

## CLEANING BEHAVIOR AMONG MARINE FISHES AND INVERTEBRATES IN THE CANARY ISLANDS

by

James L. VAN TASSELL (1), Alberto BRITO (2) and Stephen A. BORTONE (3)

**ABSTRACT.**- Previously undocumented cleaning behavior of fishes by the arrow crab *Stenorhynchus lanceolatus* was observed in the Canary Islands. The cleaning behavior of the wrasses, *Thalassoma pavo* and *Coris julis*, and the shrimp *Lysmata grabhami* are documented. Comparisons are made between species of fish that act as cleaners in the Canary Islands and the Mediterranean Sea. A table listing 132 cleaners world wide with updated taxonomic names and geographic distributions is included.

**RÉSUMÉ.**- Le comportement de nettoyage, jusqu'à présent non signalé, de poissons par le crabe *Stenorhynchus lanceolatus* a été observé aux Iles Canaries. Le comportement de nettoyage des Labridés, *Thalassoma pavo* et *Coris julis*, et de la crevette *Lysmata grabhami* est aussi décrit. Les espèces de poissons qui se comportent comme nettoyeurs aux Iles Canaries et en Mer Méditerranée sont comparées. Une liste de 132 espèces de nettoyeurs (poissons et crustacés) avec leur distribution géographique est présentée dans un tableau.

**Key-words.** - *Abudefduf*, *Coris*, *Kyphosus*, *Serranus*, *Sparisoma*, *Thalassoma*, crab, *Stenorhynchus*, shrimp, *Lysmata*, Canary Islands, MED, Cleaning behavior.

Around the world cleaning behavior has been documented for 112 fish species from 29 families and 20 invertebrate species from 4 families (Table I). Most cleaning has been observed in shallow tropical waters, where several authors believe such behavior to be more common than in temperate waters (Limbaugh, 1961; Feder, 1966). Hobson (1969), however, attributed the tropical preponderance of cleaning behavior records to the lack of observations in temperate waters. With the increase in SCUBA and underwater photography activities during the past ten years in temperate waters, this disparity has decreased. For example, between 1972 and 1984, eleven new records of cleaning behavior from the northeast Atlantic and Mediterranean were reported. Many of the records were published in European recreational SCUBA magazines rather than in scientific journals. Moosleitner (1980) summarized the cleaning observations from the Mediterranean published in SCUBA magazines.

---

(1) Department of Herpetology and Ichthyology, American Museum of Natural History, New York, NY 10024, USA.

(2) Departamento de Biología Animal (Ciencias Marinas), Universidad de La Laguna, Islas Canarias, SPAIN.

(3) Department of Ecology and Evolutionary Biology, University of West Florida, Pensacola, Florida 32514, USA.

Fishes previously recorded as cleaners from the temperate waters of the northeast Atlantic Ocean and Mediterranean Sea include: the blenny - *Parablennius rouxi*; the labrids - *Coris julis*, *Symphodus melanocercus*, *S. ocellatus*, *S. tinca*, and *Thalassoma pavo*; the sparids - *Diplodus puntazzo* and *Oblada melanura*; and the remoras - *Echeneis naucrates* and *Remora remora*. Of these, *C. julis*, *O. melanura*, and *T. pavo* are common members of the demersal fish fauna of the Canary Islands (Bortone *et al.*, 1991).

Moosleitner (1980) noted differences in the pattern of cleaning behavior for several of these species. The wrasses, *T. pavo* and *C. julis*, are widely distributed in the Mediterranean Sea and apparently vary geographically in their cleaning activity. Juvenile *T. pavo* are cleaners in the southeastern Mediterranean, especially along the Turkish south coast, but apparently clean infrequently in other areas. Although no detailed description of *T. pavo* cleaning behavior was reported by Moosleitner (1980), several photographs depicted only a single *T. pavo* engaged in the cleaning bout. Juvenile *C. julis* are apparently opportunistic cleaners and were frequently observed cleaning in the northwest Mediterranean but rarely, if ever, in other areas (Moosleitner, 1980). Even within the same general geographic area, individuals differed in the frequency at which they cleaned.

From 1985 through 1992 *T. pavo* was observed cleaning on five occasions, while *C. julis* was observed only once in the summer of 1991. The shrimp, *Lysmata grabhami* (generally found in association with the anemone, *Telmatactis* sp.) was observed frequently cleaning many species of fishes, and the arrow crab, *Stenorhynchus lanceolatus*, is documented here as a cleaner for the first time.

## MATERIALS AND METHODS

Since 1989, we have been surveying shorefish populations in the Canary Islands (the islands of El Hierro, Gomera, Fuerteventura, and Gran Canaria) using the visual survey point count method (Bortone *et al.*, 1989). This method has allowed us to quantify shorefish populations without disturbing the habitat or fish populations. It has also afforded us the opportunity to observe behavioral interactions among these fishes. From 1989 through 1992, we accumulated over 560 hrs of underwater observations in the Canary Islands. Here we summarize our observations of cleaning behavior in the Canary Islands and compare them to published observations of cleaning behavior in the Mediterranean.

A summary of known cleaners that occur throughout the world was compiled from both scientific and non-scientific sources (Table I). This table updates taxonomic nomenclature and presents a general geographic distribution for each species. The term "cleaner" as used in this paper refers to any fish or invertebrate observed "pecking" at another fish whether ectoparasites or necrotic tissue were present or not.

Table I. - Systematic list of Teleost fishes and invertebrates in which cleaning behavior has been reported, listed alphabetically by family.

### TELEOST CLEANERS

#### Apogonidae

*Siphamia versicolor* - Nicobar Islands; Eibl-Eibesfeldt, 1961.

#### Blenniidae

*Parablennius rouxi* - Mediterranean; Moosleitner, 1980.

#### Balistidae

*Canthidermis maculatus* - Tropical Atlantic and Pacific; Gooding, 1964.



# Callichthyidae

*Corydoras paleatus* - Artificially induced, S. America fresh water; Wickler, 1956.

*Corydoras aeneus* - S. America fresh water; G. Barlow in Feder, 1966.

# Carangidae

*Caranx ruber* - Caribbean; Randall, 1962.

*Naucrates ductor* - Worldwide tropical and temperate; Wahlert and Wahlert, 1961.

# Centrarchidae

*Lepomis macrochirus* - Fresh water North America; Powell, 1984. Sulak, 1975.

*Pomoxis annularis* - Fresh water North America; Spall, 1970.

# Chaetodontidae

*Chaetodon litus* - Easter Island; Allen, 1978.

*Heniochus diphreutes* - East Africa to Hawaiian Islands; Randall *et al.*, 1990.

*Johnrandallia nigrirrostris* - Gulf of California west coast of Mexico; Feder, 1966.

# Cichlidae

*Paretroplus maculatus* - Observed cleaning in aquaria, Africa; Wyman and Ward, 1972.

*Haplochromis teunisrasi* - Mwanza Gulf, Lake Victoria; Witte and Van Oijen, 1990.

*Haplochromis cnester* - Mwanza Gulf, Lake Victoria; Witte and van Oijen, 1990.

*Docimodus evelynae* - Lake Malawi; Ribblink, 1984.

*Melanochromis parallelus* - Lake Malawi; Baker, 1991.

*Pseudotropheus crabro* - Lake Malawi; Ribblink and Lewis, 1982.

# Cyprinidae

*Alburnus alburnus* - Fresh water, northern Europe; Abel, 1971.

*Labeo cylindricus* - Observed in aquaria, fresh water, Africa; Minshall, 1985.

*Rhodeus amarus* - Fresh water, northwestern Europe; Abel, 1971.

*Rutilus* - Freshwater, northern Europe and Sweden; Abel, 1971.

*Scardinius erythrophthalmus* - Freshwater, northern Europe; Abel, 1971.

*Tinca tinca* - Fresh water, Europe; Abel, 1971.

# Cyprinodontidae

*Cyprinodon variegatus* - Fresh water, North America; Arndt, 1973.

# Echeneidae

*Echeneis naucrates* - Warm Atlantic and Indo-Pacific; Randall, 1962.

*Remora remora* - Worldwide tropical and temperate; Szidat and Nani, 1951; Maul, 1956.

*Remora brachyptera* - Worldwide tropical and temperate; Strasburg, 1959.

*Remora pallida* (= *R. brachyptera*) - Warm Atlantic and Indo-Pacific; Strasburg, 1959.

# Embiotocidae

*Brachyistius frenatus* - Vancouver Is. to central Baja California; Limbaugh, 1955; Hubbs and Hubbs, 1954.

*Embiotoca* sp. - Central California to central Baja California; Limbaugh, 1955.

*Embiotoca jacksoni* - Coastal marine in north Pacific; Hobson, 1969.

*Hypsurus caryi* - Coastal marine in north Pacific; Gotshall, 1967.

*Phanerodon atripes* - Coastal marine in north Pacific; Hobson, 1969.

*Rhacochilus vacca* - juveniles, Alaska to northern Baja California; Limbaugh, 1955.

# Fundulidae

*Adinia xenica* - Fresh water, North America; Arndt, 1973.

*Fundulus confluentus* - Fresh water, North America; Arndt, 1973.

*Fundulus heteroclitus* - Gulf of St. Lawrence to Gulf of Mexico; McCutcheon and McCutcheon, 1964.

# Gasterosteidae

*Apeltes quadracus* - Northwest Atlantic; Tyler, 1963.

# Gobiesocidae

*Cochleocephalus bicolor* - Southern and southwestern, Australia; Hutchins, 1991.

*Cochleocephalus orientalis* - New South Wales; Hutchins, 1991.

# Gobiidae

*Elacatinus digueti* - Baja, California; Hobson, 1968.

*Elacatinus genie* - Caribbean; Colin, 1975.

- Elacatinus evelynae* - Caribbean; Losey, 1974.  
*Elacatinus illecebrosus* - Panama; Colin, 1975.  
*Elacatinus oceanops* - Caribbean; Longley and Hildebrand, 1941; Eibl-Eibesfeldt, 1955, Randall, 1958.  
*Elacatinus prochilos* - Lesser Antilles; Darcy *et al.*, 1974.  
*Elacatinus puncticulatum* - West coast of Mexico; Limbaugh, 1960 in Feder, 1966.  
*Elacatinus randalli* - Caribbean; Colin, 1975.  
*Elacatinus (Tigrigobius) sp.* - Southern California; Colin, 1975.  
Grammatidae  
*Gramma loreto* (= *G. hemichrysos*) - Bahamas; Eibl-Eibesfeldt, 1955.  
Haemulidae  
*Anisotremus virginicus* - Florida to West Indies; Randall and Randall, 1960; Longley and Hildebrand, 1941; Eibl-Eibesfeldt, 1955.  
Kyphosidae  
*Girella simplicidens* - Mexico; McCourt and Thomson, 1984.  
Labridae  
*Bodianus axillaris* - Indo-Pacific; Baensch, 1992.  
*Bodianus diana* - Indo-Pacific; Randall (pers. comm.).  
*Bodianus diplotaenia* - Gulf of California, Clipperton Is.; Feder, 1966. Ray and Ciampi, 1956.  
*Bodianus rufus* - West Indies; Eibl-Eibesfeldt, 1955, Feder, 1966.  
*Bodianus pulchellus* - Florida and Antilles; Randall, 1958, 1962.  
*Centrolabrus exoletus* - N.E. Atlantic; Potts, 1973.  
*Coris giofredi* (= *C. julis*) - Mediterranean; Eibl-Eibesfeldt, 1959.  
*Coris julis* - Mediterranean; Moosleitner, 1980.  
*Coris picta* - Australia; Doak, 1972.  
*Coris sandageri* - Australia; Doak, 1972.  
*Diproctacanthus xanthurus* - Philippines, Palau, Indonesia, New Guinea, Great Barrier Reef; Randall *et al.*, 1990.  
*Ctenolabrus rupestris* - Observed cleaning in aquaria, Northeast Atlantic; Potts, 1973.  
*Halichoeres nicholsi* - Eastern Tropical Pacific; McCourt and Thomson, 1984.  
*Iridio bivitatus* - Caribbean; Beebe in de Beaufort, 1940.  
*Larabicus quadrilineatus* - Red Sea and Gulf of Aden; Randall, 1986.  
*Labroides bicolor* - Indo-Pacific; Randall, 1958.  
*Labroides dimidiatus* - Africa to tropical Pacific; Hiatt & Strasburg 1960; Cousteau, 1956; Marden, 1956; de Beaufort, 1940; Randall, 1955, 1958.  
*Labroides pectoralis* - Western Pacific and eastern Indian Ocean; Randall and Springer, 1975.  
*Labroides phthirophagus* - Hawaiian Islands; Randall, 1958.  
*Labroides rubrolabiatus* - Caroline Atoll, Tahiti, Moorea, Society Is., Tuamotus, Marquesas; Randall, 1958.  
*Labropsis australis* - Samoa and Fiji to Great Barrier Reef; Randall *et al.*, 1990.  
*Oxyjulis californica* - Central California to central Baja California; Guadalupe Is.; Hubbs and Hubbs, 1954; Limbaugh, 1955, 1961.  
*Pseudodax moluccanus* - Indo-Pacific; Randall *et al.*, 1990.  
*Semicossyphus pulcher* - Pacific coast of California; McCourt and Thomson, 1984.  
*Suezichthys aylingi* - Southern New South Wales, eastern Tasmania; Hutchins and Swainston, 1986.  
*Symphodus (Crenilabrus) melanocercus* - Mediterranean; von Wahlert and Wahlert, 1961.  
*Symphodus (Crenilabrus) melops* - In aquaria, NE Atlantic, Mediterranean; Potts, 1973.  
*Symphodus (Crenilabrus) ocellatus* - Mediterranean; Moosleitner, 1980.  
*Symphodus (Crenilabrus) tinca* - Mediterranean; Moosleitner, 1980.  
*Symphodus (Crenilabrus) quinquemaculatus* (= *Symphodus (Crenilabrus) roissali*) - Mediterranean; Moosleitner, 1980.  
*Thalassoma bifasciatum* - Juvenile, Caribbean; Longley and Hildebrand 1941; Ray and Ciampi, 1956; Randall, 1958; Randall and Randall, 1960; Eibl-Eibesfeldt, 1955.  
*Thalassoma duperrey* - Hawaiian Islands; Randall, 1985.

- Thalassoma klunzingeri* - Red Sea; Randall, 1986.  
*Thalassoma lucasanum* - Gulf of California, West coast of Mexico; Feder, 1966.  
*Thalassoma lunare* - Red Sea; Randall, 1986.  
*Thalassoma lutescens* - Australia; McCourt and Thomson, 1984.  
*Thalassoma pavo* - As juveniles in the Canary Islands, Azores, Madeira, Mediterranean, Portugal south to Cape Lopez; Moosleitner, 1980.
- Monodactylidae  
*Monodactylus argenteus* - Australia; A. Gill (pers. comm.).
- Percidae  
*Perca fluviatilis* - Freshwater, Northern Europe and Asia; Abel, 1971.
- Pomacanthidae  
*Holacanthus ciliaris* - Western Atlantic; Allen, 1978.  
*Holacanthus passer* - Galapagos, South America; Feder, 1966.  
*Holacanthus limbaughi* - Clipperton Islands; Colin, 1975.  
*Pomacanthus paru* - Western tropical Atlantic and Ascension Islands; Colin, 1975, Allen, 1978.  
*Pomacanthus arcuatus* - Western Atlantic; Colin, 1975.  
*Pomacanthus zonipectus* - Eastern Tropical Pacific; McCourt and Thomson, 1984.
- Pomacentridae  
*Abudefduf saxatilis* - Tropical western Atlantic; Colin, 1975.  
*Abudefduf troschelii* - Galapagos, South America; Hobson, 1969; McCourt and Thomson, 1984.  
*Microspathodon* sp.- Juvenile, Gulf of California, west coast of Mexico, Clipperton Is.; Limbaugh, 1960 in Feder, 1966.  
*Microspathodon chrysurus* - Tropical western Atlantic; Randall, 1958.  
*Microspathodon dorsalis* - Eastern Tropical Pacific; Hobson, 1965.
- Scaridae  
*Scarus* sp.- Juvenile in the Caribbean; Limbaugh, 1960 in Feder, 1966.
- Scorpididae  
*Atypichthys straigatus* - Australia; A. Gill (pers. comm.).
- Sparidae  
*Oblada melanura* - Mediterranean; Moosleitner, 1980.  
*Diplodus puntazzo* - Mediterranean; Moosleitner, 1980.
- Syngnathidae  
*Entelurus aequoreus* - Observed in laboratory, Mediterranean and Eastern. Atlantic to Norway; Randall, 1962.  
*Syngnathus acus* - In aquaria, Mediterranean; Potts, 1973.  
*Syngnathus typhle* - In aquaria, Eastern Atlantic, Mediterranean; Potts, 1973.  
*Doryrhamphus melanopleura* - South Central Pacific; McCourt and Thomson, 1984.
- Tetraodontidae  
*Canthigaster punctatissima* - Eastern Tropical Pacific; McCourt and Thomson, 1984.

## INVERTEBRATE CLEANERS

- Hippolytidae  
*Lysmata amboinensis* - Indo-Pacific; Baensch, 1992.  
*Lysmata californica* - Santa Barbara, California to Baja California, Guadalupe Is., Mexico; Limbaugh *et al.*, 1961.  
*Lysmata debelius* - Indo-Pacific; Baensch, 1992.  
*Lysmata galapagensis* - Western South America and Galapagos; Baensch, 1992.  
*Lysmata grabhami* - Maderia, Florida, Bahamas; Limbaugh *et al.*, 1961; Randall, 1958.  
*Lysmata kuekenthali* - Indian Ocean; Baensch, 1992.  
*Lysmata seticaudata* - Mediterranean; Baensch, 1992.  
*Lysmata rathbunae* - Eastern North Atlantic; Baensch, 1992.  
*Lysmata vittata* - Australia; Baensch, 1992.



*Lysmata wurdemanni* - Caribbean to Brazil; Baensch, 1992.

*Parhippolyte uveae* - Indo-Pacific; Baensch, 1992.

#### Palaemonidae

*Brachycarpus biunguiculatus* - Mediterranean; Jonasson, 1987.

*Leandrites cyrtorhynchus* - Indo-Pacific; Jonasson, 1987.

*Parapandulus longicauda* - Gulf of Mexico; Jonasson, 1987.

*Periclimenes anthophilus* - Bermuda; Jonasson, 1987.

*Periclimenes pedersoni* - Bahamas, Virgin Is., west Florida, British West Indies; Chase, 1958.

*Periclimenes yucatanicus* - Southern Florida to Columbia, Bahamas, Virgin Is., Puerto Rico; Limbaugh *et al.*, 1961.

#### Stenopodidae

*Stenopus hispidus* - Indo-Pacific, west Atlantic, Bermuda to north coast of S. America; Limbaugh *et al.*, 1961.

*Stenopus scutellatus* - Bermuda to Brazil, Bahamas; Limbaugh *et al.*, 1961.

#### Majidae

*Stenorhynchus lanceolatus* - Canary Islands, Reported herein.

## OBSERVATIONS

### *Thalassoma pavo*

We first observed the wrasse, *T. pavo*, cleaning on 9 August 1985 off the south shore of Gran Canaria. An aggregation of five juvenile *T. pavo* was seen cleaning the parrotfish, *Sparisoma cretense*. The cleaning bout took place on the edge of a small rock cliff at a depth of 19 m. Since the initial stages of cleaning were not observed, it is unknown whether the host or the cleaner initiated the activity. When first observed (by JVT) the parrotfish was in a "head-up" position near a rock wall. All fins of the parrotfish (including paired fins) were fully extended and the color of the host was darker than normal. No damaged tissue or ectoparasites were evident on the host from a distance of three meters. Five *T. pavo* were involved in this cleaning bout, with three or four fish actively cleaning the host at any one time (Fig. 1). The wrasses maintained a "head-up" position at an angle of 45 degrees during most of the cleaning, and they generally remained on or near the dorsal surface of the host. The cleaning bout lasted at least ten minutes. No cleaning was observed at or near this particular location after repeated visits to the site. It is, therefore, unlikely that these *T. pavo* maintained a "cleaning station".

In August of 1986, off the northwest shore of Gomera (near Playa de Arguamul), several (5-8) *T. pavo* were observed by one of us (AB) cleaning a Bermuda sea chub, *Kyphosus sectatrix* at a depth of 12 m. The color of the host was paler than normal, while the *T. pavo* retained their normal color. The host was in a "head-up" position near the bottom. The initial stages of cleaning were not observed; therefore, the duration of the cleaning bout is not known.

On 28 July 1989, between 12.00 and 13.00 hrs, *Thalassoma pavo* was twice observed by one of us (SAB) cleaning a male parrotfish, *S. cretense*, near Tejada on the southern coast of the island of El Hierro. The *S. cretense* (7 cm TL, total length) was in a head-up position 2 cm above a 1.5 m rock in 8 m of water. The cleaning lasted for 10 minutes during which time the *T. pavo* (5 cm TL) pecked five times at the fins and head of the parrotfish. On 12 August 1989 *T. pavo* was observed cleaning an *Abudefduf luridus* (12 cm TL) near El Faro. The *T. pavo* (6 cm TL) pecked six times at the tail of the *A. luridus*, which was in a head-up position 6 m off the bottom.



Fig. 1. - Several wrasses, *Thalassoma pavo*, cleaning a parrotfish.

On 25 July 1990, between 13.15 and 14.15 hrs, *T. pavo* was again observed by one of us (SAB) cleaning off Fuerteventura, 4 km north of Corralejo at Calamar, at a depth of 19 m. A group of four juvenile *T. pavo* were observed cleaning the damsel fish, *A. luridus*. The *A. luridus* was in a head down position about 1 m away from a vertical rock ledge. The cleaning was observed for a period of 10 seconds.

In August of 1992, JVT observed a juvenile male parrotfish, *S. cretense*, attempting to initiate cleaning from a group of seven *T. pavo*. The *T. pavo* were feeding on a small vertical rock face at a depth of 4 meters when the *S. cretense* approached. The parrotfish moved in front of the *T. pavo*, next to the vertical surface of the rock, and assumed the "head-up" position, with fins spread. *T. pavo* did not react to the posturing. The parrotfish then swam in a small circle and returned to the rock wall again assuming the "head-up" position. This time he spread his fins further and arched his body more than the first time. He remained in this position while moving slowly in front of the *T. pavo*. The wrasses did not clean the parrotfish and after the wrasses left the vertical rock surface, the parrotfish swam away in a different direction. There were no parasites or any damaged tissues visible on the parrotfish.

### *Coris julis*

The wrasse, *Coris julis*, was observed cleaning only once in the Canary Islands by Richard Cody in 1990 (pers. comm.) on Fuerteventura, about 1.5-2.0 km south of Corralejo beach. One *C. julis* (11 cm TL) was observed removing a large isopod from a seabass, either *Serranus cabrilla* or *S. atricauda* (18 cm TL). The *Serranus* sp. was positioned about 20 cm above the peak of a large boulder in 5 m of water. The *C. julis* removed and partly ate the isopod but did not continue to clean the *Serranus* sp. or any other fish in the area. The cleaning lasted for several minutes.



### *Lysmata grabhami*

The shrimp, *Lysmata grabhami*, that was previously documented as a cleaner by Limbaugh (1961), is common in the Canary Islands. This shrimp is known to occur off Madeira, Florida and the Bahamas. It has been confused in the past with the Indo-Pacific *L. amboinensis*. In the Canary Islands, *L. grabhami* generally associates with the great anemone, *Telmatactis* sp. The anemone is commonly found on vertical rock walls or in large crevices. *L. grabhami* maintains a cleaning station and has been observed by one of us (AB) to clean the moray eels *Muraena helena*, *Gymnothorax unicolor* and *Enchelycore anatina*, the marbled torpedo ray *Torpedo marmorata*, and the goatfish *Mullus surmuletus*.

### *Stenorhynchus lanceolatus*

The arrow crab, *Stenorhynchus lanceolatus*, has not been previously documented as a cleaner. *S. lanceolatus* is an eastern Atlantic species, known from Madeira and the Canary and Cape Verde Islands, as well as from many localities along the African mainland between the Spanish Sahara and Angola (Manning and Holthuis, 1981). One of us (AB) has observed it cleaning in the Canary Islands. This crab is frequently found in association with the urchin, *Diadema antillarum*, but may also be found in cracks and crevices lacking urchins. We have observed it cleaning the moray eels *Muraena helena* and *Enchelycore anatina*.

## DISCUSSION

Moosleitner (1980) showed that individuals of *Thalassoma pavo* and *Coris julis* exhibit different cleaning behavior patterns at different localities within the Mediterranean Sea. He stated that *T. pavo* is a cleaner in the juvenile stage which will clean almost any fish species, even species that have migrated into the Mediterranean from the Red Sea. While he did not state the number of juveniles involved in the cleaning process, the photographs included in his publication indicate that only a single individual wrasse was involved. We have documented herein that cleaning by *T. pavo*, in the Canary Islands, may involve several juveniles simultaneously.

Moosleitner (1980) reported *C. julis* as an opportunistic cleaner in some areas of the Mediterranean and a frequent cleaner in other areas. He noted that within a given area there were differences in the number of observed occurrences of cleaning between individuals. We observed only infrequent cleaning by *C. julis* in the Canary Islands. The species should be considered an opportunistic cleaner in the Canaries.

The family Labridae contains 30 species currently documented as cleaners, with three genera (*Labroides*, *Symphodus*, and *Thalassoma*) and 14 species of cleaners. The genus *Thalassoma* has several species documented as cleaners in the juvenile stage. They include *T. lucasanum* from the Gulf of California and the west coast of Mexico (Hobson, 1965), *T. bifasciatum* from the Caribbean (Eibl-Eibesfeldt, 1955), and *T. pavo* from the Canary Islands and Mediterranean. Apparently *Thalassoma* spp. do not depend solely on cleaning as a food source (Randall, 1967).

From the diversity of species listed in table I, it is evident that cleaning must have evolved independently within the groups. The labrids contain more cleaners than the other groups perhaps due to their plucking mode of feeding and dentition. Among the teleosts as a whole, there are few species that depend entirely on cleaning as a source of food; the genus *Labroides* is apparently the exception. Most of the fish species that clean do so only as juveniles.



**Acknowledgements.** - This study was funded by a grant from Earthwatch and the Center for Field Research. We wish to thank Dr. Anthony Gill for his comments on the manuscript and his help in identifying additional literature references to cleaning. We thank Drs. Richard Lund, Peter Moller, and Melanie Stiasny for comments and suggestions on the manuscript. Gay Oulton, John and Ann Holmes, and the many people of the Canary Islands helped coordinate the expedition logistics and gave us their support for the past 15 years. To them we are extremely grateful. We also wish to thank the Alcalde del Ilte, Ayuntamiento de Mogan; Comandancia Militar de Marina, Las Palmas de Gran Canaria; and the Ayudantia Militar de Marina, Arguineguin for giving us permission to conduct research in the Canary Islands.

## REFERENCES

- ABEL E.F., 1971. - Zur Ethologie von Putzsymbiosen einheimischer Süßwasserfische im natürlichen Biotop. *Oecologia* (Heidelb), 6: 133-151.
- ALLEN G.R., 1978. - Butterfly and Angelfishes of the World. vol. 2, 352 pp. Wiley-Interscience Pub. New York.
- ARNDT R.G., 1973. - Cleaning symbiosis in some Florida brackish water cyprinodonts. *Mar. Aquarist*, 4(3): 5-13.
- BAENSCH H.A. & H. DEBELIUS, 1992. - Meerwasser Atlas - Die gemeinsame Pflege von Wirbellosen Tieren und tropischen Meeresfischen im Aquarium. 1216 pp. Mergus Press, Melle.
- BAKER T., 1991. - Cichlids as cleaner fish. *Cichlidae*, 12(1): 1-3.
- BEAUFORT L.F. de, 1940. - The Fishes of the Indo-Australian Archipelago VIII. 508 pp. E.J. Brill. Leiden.
- BORTONE S.A., KIMMEL J.J. & C.M. BUNDRICK, 1989. - A comparison of three methods for visually assessing reef fish communities: time and area compensated. *Northeast Gulf Sci.*, 10(2): 85-96.
- BORTONE S.A., VAN TASSELL J., BRITO A., FALCÓN J.M. & C.M. BUNDRICK, 1991. - A visual assessment of the inshore fishes and fishery resources off El Hierro, Canary Islands: a baseline survey. *Sci. Mar.*, 55: 529-541.
- CHACE F.A. Jr., 1958. - A new shrimp of the genus *Periclimenes* from the West Indies. *Proc. Biol. Soc. Wash.*, 71: 125-130.
- COLIN P., 1975. - The Neon Goby - The Comparative Biology of the Gobies of the Genus *Gobiosoma*, subgenus *Elacatinus*, (Pisces: Gobiidae) in the Tropical Western North Atlantic Ocean. 304 pp. T.F.H. Publications, Neptune City, NJ.
- COUSTEAU J., 1956. - Exploring Davy Jones locker with Calypso. *Nat. Geogr. Mag.*, 109: 149-161.
- DARCY G.H., MAISEL E. & J. C. OGDEN, 1974. - Cleaning preferences of the gobies *Gobiosoma evelynae* and *G. prochilos* and the juvenile wrasse *Thalassoma bifasciatum*. *Copeia*, 1974(2): 375-379.
- DOAK W., 1972. - Fishes of the New Zealand Region. 132 pp. Hodder and Stoughton, Sydney.
- EIBL-EIBESFELDT I., 1955. - Ueber Symbiosen, Parasitismus und andere besondere zwischenartliche Beziehungen tropischer Meeresfische. *Tierpsychologie*, 12(2): 203-219.
- EIBL-EIBESFELDT I., 1959. - Der Fisch *Aspidontus taeniatatus* als Nachahmer des Putzers *Labroides dimidiatus*. *Tierpsychologie*, 16: 19-25.
- EIBL-EIBESFELDT I., 1961. - Eine Symbiose zwischen Fischen (*Siphamia versicolor*) und Seeigeln. *Tierpsychologie*, 18: 56-59.
- FEDER H.M., 1966. - Cleaning symbiosis in the marine environment. pp. 327-380. In: *Symbiosis*, vol 1. (Henry S.D., ed.). Academic Press, New York.
- GOODING R.M., 1964. - Observations of fish from a floating observation raft at sea. *Proc. Hawaii. Acad. Sci.*, 39: 27.
- GOTSHALL D.W., 1967. - Cleaning symbiosis in Monterey Bay, California. *Calif. Fish Game*, 53: 125-126.
- HIATT R.W. & D.W. STRASBURG, 1960. - Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. *Ecol. Monogr.*, 30: 65-127.

- HOBSON E.S., 1965. - Diurnal-nocturnal activity of some inshore fishes in the Gulf of California. *Copeia*, 1965(3): 291-302.
- HOBSON E.S., 1968. - Predatory behavior of some shore fishes in the Gulf of California. *Fish Wildl. Serv. Res. Rep.*, 73: 192.
- HOBSON E.S., 1969. - Comments of certain recent generalizations regarding cleaning symbiosis in fishes. *Pac. Sci.*, 23: 35-39.
- HUBBS C.L. & L.C. HUBBS, 1954. - Data on the life history, variation, ecology, and relationships of the kelp perch, *Brachyistius frenatus*, an embiotocid fish of the Californias. *Calif. Fish Game*, 40: 183-198.
- HUTCHINS B.J., 1991. - Description of three new species of gobioid fishes from southern Australia, with a key to the species of *Cochleocephalus*. *Rec. West. Aust. Mus.*, 15(3): 655-672.
- HUTCHINS B. & R. SWAINSTON, 1986. - Sea Fishes of Southern Australia. 180 pp. Swainston Publishing, Perth.
- JONASSON M., 1987. - Fish cleaning behavior of shrimp. *J. Zool., (Lond.)*, 213: 117-131.
- LIMBAUGH C., 1955. - Fish life in the kelp beds and the effects of kelp harvesting. *Rect. No. 59, Inst. Mar. Resour.*, 155 pp. Univ. Calif. at La Jolla.
- LIMBAUGH C., 1961. - Cleaning symbiosis. *Sci. Am.*, 205: 42-49.
- LIMBAUGH C., PEDERSON H. & F.A. CHACE Jr., 1961. - Shrimps that clean fishes. *Bull. mar. Sci. Gulf Caribb.*, 11: 237-257.
- LONGLEY W.H. & S.F. HILDEBRAND, 1941. - Systematic catalogue of the fishes of Tortugas, Florida. *Pap. Tortugas Lab.*, 34: 1-331.
- LOSEY G.S. Jr., 1974. - Cleaning symbiosis in Puerto Rico with comparison to the tropical Pacific. *Copeia*, 1974(4): 960-970.
- MCCOURT R.M. & D.A. THOMSON, 1984. - Cleaning behavior of the juvenile panamic sergeant major *Abudefduf troschelii* with a resume of cleaning associations in the Gulf of California, Mexico and adjacent waters. *Calif. Fish Game*, 70(4): 234-239.
- MCCUTCHEON F.H. & A.E. MCCUTCHEON, 1964. - Symbiotic behavior among fishes from temperate ocean waters. *Science*, 145: 948-949.
- MANNING R.B. & L.B. HOLTHUIS, 1981. - West African brachyuran crabs. *Smithson. Contrib. Zool.*, 306: 1-379.
- MARDEN L., 1956. - Camera under the sea. *Natl Geogr. Mag.*, 109: 162-200.
- MAUL G.E., 1956. - Monografia dos peixes do Museu Municipal do Funchal. Ordem Discocephali. *Bol. Mus. Munic. Funchal*, 9: 5-75.
- MINSHULL J.L., 1985. - Cleaning behaviour among the cichlid fish *Tilapia rendalli rendalli* Boulenger 1896 and the cyprinid, *Labeo cylindricus* Peters, 1852. *Limnol. Soc. South Afr.*, 11(1): 20-21.
- MOOSLEITNER V.H., 1980. - Putzerfische und -garnelen im Mittelmeer. *Zool. Anz.*, 205(1980)3/4: 210-240.
- POTTS G.W., 1973. - Cleaning symbiosis among British fish with special reference to *Crenilabrus melops* (Labridae). *J. mar. Biol. Ass. UK*, 53: 1-10.
- POWELL J.A., 1984. - Observations of cleaning behavior in the bluegill *Lepomis macrochirus*, a centrarchid. *Copeia*, 1984(4): 996-998.
- RANDALL J.E., 1955. - Fishes of the Gilbert Islands. *Atoll Res. Bull.*, 47: 1-243.
- RANDALL J.E., 1958. - A review of the labrid fish genus *Labroides*, with a description of two new species and notes on ecology. *Pac. Sci.*, XII(4): 327-347.
- RANDALL J.E., 1962. - Fish service stations. *Sea Frontiers*, 8: 40-47.
- RANDALL J.E., 1967. - Food habits of reef fishes of the West Indies. *Stud. trop. Oceanogr. Miami*, 5: 665-847.
- RANDALL J.E., 1985. - Guide to Hawaiian Reef Fishes. 74 pp. Harrowood Books. Newtown Square, PA.
- RANDALL J.E., 1986. - Red Sea Reef Fishes. 192 pp. Immel Pub. London.
- RANDALL J.E., ALLEN G.R. & R.C. STEENE, 1990. - Fishes of the Great Barrier Reef and Coral Sea. 507 pp. University of Hawaii Press.
- RANDALL J.E. & H.E. RANDALL, 1960. - Examples of mimicry and protective resemblance in tropical marine fishes. *Bull. mar. Sci. Gulf Caribb.*, 10(4): 444-480.



- RANDALL J.E. & V.G. SPRINGER, 1975. - *Labroides pectoralis*, a new species of labrid fish from the tropical western Pacific. *Jap. J. Ichthyol.*, vol. 22(25): 411-422.
- RAY C. & E. CIAMPI, 1956. - The Underwater Guide to Marine Life. 338 pp. A.S. Barnes, New York.
- RIBBINK A.J., 1984. - Feeding behaviour of a cleaner and scale, skin and fin eater from Lake Malawi (*Docimodus evelynae*, Pisces, Cichlidae). *Neth. J. Zool.* 34(2):182-196.
- RIBBINK A.J. & D.S.C. LEWIS, 1982. - *Melanochromis crabro* sp. nov. a cichlid from Lake Malawi which feeds on ectoparasites and catfish eggs. *Neth. J. Zool.* 32(1):72-87.
- SPALL R.D., 1970. - Possible cases of cleaning symbiosis among freshwater fishes. *Trans. Am. Fish. Soc.*, 99(3): 599-600.
- STRASBURG D.W., 1959. - Notes on the diet and correlating structures of some central Pacific echeneid fishes. *Copeia*, 1959(3): 244-248.
- SULAK K.J., 1975. - Cleaning behavior in the centrarchid fishes *Lepomis macrochirus* and *Micropterus salmoides*. *Anim. Behav.*, 23: 331-334.
- SZIDET L. & A. NANI, 1951. - Las remoras del Atlantico Austral con un estudio de su nutricion natural y de parasitos (Pisc. Echeneidae). *Rev. Mus. Argent. Cienc. Nat.-Bernardino Rivadavia-Inst. Nac. Invest. Cienc. Nat. Zool.*, 2: 385-417.
- TYLER A.V., 1963. - A cleaning symbiosis between the rainwater fish, *Lucania parva* and the stickleback, *Apeltes quadracus*. *Chesapeake. Sci.*, 4(2): 105-106.
- WAHLERT G. VON & H. VON WAHLERT, 1961. - Le comportement de nettoyage de *Crenilabrus melanocercus* (Labridae) en Mediterranee. *Vie Milieu*, 12: 1-10.
- WICKLER W., 1956. - Eine Putzsymbiose zwischen *Corydoras* und *Trichogaster*. *Tierpsychologie*, 13: 46-49.
- WITTE F. & M.J.P. VAN OIJEN, 1990. - Taxonomy, ecology and fishery of Lake Victoria haplochromine trophic groups. *Zool. Verh. (Leiden)*, 262: 1-47.
- WYMAN R.L. & J.A. WARD, 1972. - A cleaning symbiosis between the cichlid fishes *Eetroplus maculatus* and *Eetroplus suratensis*. I. Description and possible evolution. *Copeia*, 1972(4): 834-838.

Reçu le 21.06.1993.

Accepté pour publication le 05.08.1993.